Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

84 Mr
cop. 3

Studies of

WATERMELON LOADING

FOR RAIL SHIPMENT, 1953

LIBRARY
CURRENT SERIAL RECORD
JUN 8 - 1954
U. S. DEPARTMENT OF AGRICULTURE

Marketing Research Report No. 62

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
Washington, D. C.
May 1954

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 20 cents

ACKNOWLEDGMENTS

The shipping experiments described and summarized in this report were made possible through the efforts and cooperation of a number of individuals and organizations.

For their work in conducting and inspecting the test shipments and in analyzing and interpreting the results, credit is due members of the Agricultural Marketing Service, as follows: Robert C. Burk, Randall C. Cubbedge, B. A. Friedman, H. W. Hruschka, J. M. Lutz, C. A. Melvin, Earl F. Nelson, Louis J. Mancuso, W. A. Radspinner, G. B. Ramsey, and B. P. Rosanoff.

Valuable assistance also was received from the Railroad Perishable Inspection Agency, Western Weighing and Inspection Bureau, and the Federal-State inspection services and Agricultural Experiment Stations of Florida, Georgia, and South Carolina. Also cooperating in the study were the Atlantic Coast Line Railroad, Central of Georgia Railway, Pennsylvania Railroad, Seaboard Air Line Railroad, Southern Railway, and other railroads, and many watermelon shippers and distributors.

CONTENTS

	Page
Summary	iv
Introduction	1
Amount and type of transportation losses	2
Methods	7
Types of cars and loads used	7
Conventional lengthwise load	8
Other loading methods	11
Jumble load	12
Stem-end-to-stem-end load	12
Crosswise load	12
Shipment and inspection of test cars	16
Results	18
Comparative melon damage by type of load	18
Decay by type of load	22
Lengthwise impacts in relation to melon damage	24

- - o O o - -

This study was conducted in part under authority of the Agricultural Marketing Act of 1946 (RMA, Title II).

SUMMARY

Shipping tests with watermelons by rail from Florida, Georgia, and South Carolina to various destinations in 1953 showed that loading the Congo variety of melons crosswise of the car instead of lengthwise (the conventional method) resulted in 70 percent less bruising, 59 percent fewer cracked melons, and 47 percent less surface scarring than in comparable shipments loaded lengthwise. Shipments of 50 test cars loaded crosswise and 52 check cars loaded according to the conventional lengthwise method, were studied during the melon shipping season.

The substantial reduction in damage achieved through crosswise loading is attributed to the fact that the force of in-transit impacts is dispersed over a greater area of the thick rind on the sides of the melons as compared with the smaller area of thin rind at the blossom ends. Although no comparisons were made of the time required for loading cars according to the crosswise and lengthwise methods, preliminary observations indicated that the new method of loading would entail little or no increase in loading time or in material costs.

Shipping tests of 8 additional experimental loads showed that in the stem-end-to-stem-end arrangement of melons in lengthwise loads there were 22 percent fewer damaged melons than in the conventional stem-end-to-blossom-end arrangement.

In both types of lengthwise loads more than 90 percent of all damage consisted of blossom-end bruising as compared with 40 percent in the crosswise loads. Of the total damaged melons in the crosswise loads, 48 percent were affected with side bruising, most of which was apparently sustained in lengthwise thrusts or shifts of the load. For all types of loading arrangements, from 89 to 98 percent of all bruised melons were found in the ends of the cars.

Stem-end rot was the most prevalent type of decay found in melons in all loading arrangements, accounting for 58 to 75 percent of all decayed melons. Although there was less decay in the crosswise loads than in the lengthwise loads, little significance is attached to this difference.

Special impact recording devices used in 59 test and check shipments showed that all cars received at least one lengthwise impact at speeds above 4 miles per hour during transit. The crosswise loads in which impact recorders were used received more excess-speed impacts and had a higher impact-force index than the conventional lengthwise loads, but the lengthwise loads had more than 3 times as much damage as the crosswise loads. More than 75 percent of the lengthwise impacts above 4 miles per hour occurred in yards and terminals.

Additional shipping tests will be made during the 1954 season to supplement the data and observations obtained during the 1953 season and to study further improvements in the new loading method.

STUDIES OF WATERMELON LOADING FOR RAIL SHIPMENT, 1953

By P. L. Breakiron, Transportation and Facilities Branch, and
J. R. Winston and J. Kaufman, Biological Sciences Branch,
Agricultural Marketing Service

INTRODUCTION

Visible injury to watermelons in the form of bruising and cracking of the rind and the resultant injury to the flesh occurring in the handling and transportation from field to market has long caused much economic loss in marketing. Although the initial cost of the damage is borne by various marketing agencies participating in the handling and distribution of the melons, the burden ultimately falls on producers and consumers.

The average damage rate in rail shipments during the 1952 season was approximately 6.3 percent of the melons shipped. On the basis of 23,828 cars of this commodity originated during that season, the equivalent of approximately 1,500 carloads of melons were, in effect, consigned to the garbage dump. The total loss to the railroads alone was $1,207,210 during the 1952 season, according to data released by the Association of American Railroads.

This problem has become more acute during the last 2 years in rail shipments from the southeastern producing areas to northern markets with the introduction of the Congo variety of melons, which appears to be especially susceptible to bruising, particularly on the blossom ends of the melons. During the 1952 season, 3,404 cars of the Congo variety shipped from the Southeast suffered 10.3 percent damage from bruising and cracking as compared with only 5.2 percent damage from the same causes found in 9,268 cars of the Cannonball variety.

The Congo, which has become popular with growers and consumers, was developed by plant breeders of the U. S. Department of Agriculture. The melon is resistant to anthracnose, is a comparatively prolific producer, and has excellent eating qualities. These desirable characteristics have led to significant increases in production and shipments from the southeastern producing areas during the last 2 years. Carlot unloads of the Congo variety at 41 rail terminals in the East increased from 675 cars in 1950 to 4,289 cars in 1953.

Indications are that production of the Congo and of several other new varieties, having the same general shape and characteristics of the Congo, will increase substantially during the next few years. It is desirable that methods of handling and loading these melons be developed to reduce transit and handling damage to a minimum if the maximum advantages are to be realized from the desirable characteristics of these improved varieties.

Concern over the high incidence of shipping and handling damage to the Congo variety led to a series of meetings of representatives of growers, shippers, and carriers with research workers of the Department of Agriculture and the Agricultural Experiment Stations of Georgia, Florida, and South Carolina in which a broad program

of research was developed. This research program had the following objectives: (1) To determine the relationship of maturity and other physical characteristics of the melons and certain cultural conditions and practices to the amount of damage suffered by the melons in handling and transportation; (2) to determine the amount and type of damage that occurs to the melons between the field and the car; and (3) to develop and test methods that would reduce damage in transit. The three agricultural experiment stations agreed to work on items (1) and (2), and research workers of the Agricultural Marketing Service assumed responsibility for the work under item (3).

Because the relatively short duration of the watermelon shipping season limits the amount of field work that can be conducted, it is probable that several seasons' work will be necessary to carry out the entire program.

A total of 50 test cars of watermelons loaded by the crosswise method were shipped from Georgia, Florida, and South Carolina to numerous destinations in a period during the 1953 season. Fifty-two check cars were loaded by the usual method, the melons being placed stem-end-to-blossom-end, lengthwise of the car. In addition, 8 test cars were loaded, the melons on one side of the car being placed lengthwise, stem-end-to-blossom-end, and on the other side lengthwise, blossom-end-to-blossom-end. The results of these tests are given in this report. It is understood that the results of the field investigations conducted at the shipping points by workers of the State agricultural experiment stations will be reported independently.

AMOUNT AND TYPE OF TRANSPORTATION LOSSES

Two principal sources of loss in the shipment and handling of watermelons are those resulting from disease, including decay, and those due to cracking and bruising. The total cost of both types of losses is considerably in excess of 1 million dollars each season. Losses from disease and decay are assumed by the grower, shipper, or the carlot or trucklot receiver, depending on who holds title to the melons when the shipments are unloaded. Most of the cost of the visible physical damage when the melons are unloaded is borne by the transportation agency in the form of loss and damage claim payments to the owner of the shipment.

Claim payments for watermelons by U. S. Class I railroads are given in table 1. They show that for the last 7 years the cost of the physical damage to melons paid by rail carriers has remained consistently at about 1 million dollars annually and that the average claim payments per car have ranged from $30.62 in 1947, to as much as $50.66 in 1952. The payment of $50.66 per car for watermelons in 1952 compares with $19.14 for all fresh fruits and vegetables, $47.88 for peaches, and $20.82 for oranges in that year. This comparison is even more significant when it is considered that watermelons are a commodity having comparatively low value.

Table 1.--Loss and damage claim payments for watermelons by all U. S. Class I Railroads, 1946-52

Year	Cars originated	Total loss and damage claim payments	Average loss and damage claim payments per car
	Number	Dollars	Dollars
1952	23,828	1,207,210	50.66
1951	25,536	947,513	37.10
1950	24,179	905,866	37.46
1949	28,500	1,114,847	39.12
1948	27,812	1,081,416	38.89
1947	32,457	993,885	30.62
1946	35,006	1,135,365	32.43

Source: Reports of the Freight Claim Division, Association of American Railroads.

A breakdown of the loss and damage claim payments for watermelons by U. S. Class I railroads from 1948 to 1952 by type or cause of damage is shown in table 2. This breakdown reveals that during the period covered by these data from 85 to 90 percent of the total claim payments were for unlocated loss and damage, which principally involved visible physical damage to the melons in the form of cracking and bruising. Claim payments for in-transit delay ranged from 5 to 9 percent of the total payments, whereas only 3 to 8 percent was paid for all other causes, which included fire, theft, and train accidents.

Table 2.--Loss and damage claim payments for watermelons by 116 U. S. Class I Railroads reporting payments by type or cause of damage, 1948-52

Year	Unlocated damage		Delay in transit		All other causes 1/		Total	
	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent
1952	991,847	88	99,304	9	33,520	3	1,124,671	100
1951	754,669	87	72,256	8	42,513	5	869,438	100
1950	743,532	90	44,461	5	38,143	5	826,136	100
1949	920,738	85	76,537	7	92,052	8	1,089,327	100
1948	897,068	86	66,790	6	86,225	8	1,050,083	100
Total or average	4,307,854	87	359,348	7	292,453	6	4,959,655	100

1/ Includes train accidents, thefts, temperature failure, defective equipment, improper handling, errors of employees, fires, and other causes.

Source: Reports of Freight Claim Division, Association of American Railroads.

Data on the total damage and decay found in rail shipments of all varieties of watermelons unloaded in 41 terminal markets from 1949 through 1953, show that bruising is considerably more prevalent than cracking (table 3). During the 1949 season there were more than twice as many bruised melons as cracked melons, but by the 1952 season, bruising damage had increased to the point where it was almost 4 times as prevalent as cracking. It appears that this very substantial increase in bruising during the last 3 seasons was due to the increased shipments of the Congo variety which is much more susceptible to blossom-end bruising than the Cannonball or Black Diamond variety. 1/ These data also show that, except for a decrease during the 1951 season, the average amount of decay remained at about the same level during the period covered by the data.

Table 3.--Number of cracked, bruised, and decayed watermelons in rail shipments unloaded at 41 terminal markets, Northeastern States, 1949-53

Year	Cars unloaded	Melons cracked		Melons bruised 1/		Melons decayed		Melons cracked, bruised, and decayed	
	Number	Total number	Average per car	Total number	Average per car	Total number	Average per car	Total number	Average per car
1949	15,004	178,630	11.9	394,585	26.3	396,878	26.4	970,093	64.6
1950	11,914	127,590	10.7	322,634	27.1	341,738	28.6	791,962	66.4
1951	12,928	139,007	10.6	577,917	40.0	262,018	20.2	979,012	75.8
1952	12,828	159,650	12.4	751,788	58.6	345,349	26.9	1,256,787	97.9
1953 2/	11,840	119,984	10.1	654,886	55.3	300,702	25.4	1,075,572	90.8

1/ Bruises were 2 inches or more in diameter.

2/ Preliminary reports, shipments from Southeastern States only.

Source: Reports of Railroad Perishable Inspection Agency.

A comparison of the relative amounts of cracking, bruising, and decay in shipments of the Congo and Cannonball varieties for the 1952 and 1953 seasons is given in table 4. These data show that although there were relatively small differences between the number of melons lost through cracking and decay for both varieties in each season, there were very significant differences in the amount of bruising. During the 1952 season, for example, shipments of the Congo variety averaged 107.6 bruised melons per car compared with an average of only 40 melons per car for the Cannonball variety. Although the amount of bruising of both varieties during the 1953 season declined somewhat, bruising in the Congo variety was almost three times as prevalent as in the Cannonball variety.

Several months before the beginning of the 1953 watermelon season a 10-percent random sample of the watermelon inspection and damage records of the Railroad Perishable Inspection Agency for cars unloaded at 41 terminal markets during the 1952 season was taken. Detailed reports were obtained for 1,303 carloads of melons covering such information as variety of melon, type of car, and extent of decay and damage. These data were analyzed to obtain certain information on the extent and distribution of damage, required for planning the experimental work conducted during the 1953 season.

1/ Also known as the Florida Giant

Table 4.--Number of cracked, bruised, and decayed watermelons in rail shipments unloaded in 41 terminal markets, by variety of melon, 1952-53

Variety of melon	Season	Cars unloaded	Melons cracked		Melons bruised 1/		Melons decayed		Melons cracked, bruised, and decayed	
		Number	Total number	Average per car	Total number	Average per car	Total number	Average per car	Total number	Average per car
Congo	1952	3.404	40,748	11.9	366,545	107.6	92,862	27.3	500,155	146.9
Cannonball 2/	1952	9,268	115,059	12.4	370,778	40.0	231,621	25.0	717,458	77.4
Congo	1953 3/	4,289	40,728	9.5	388,918	90.8	107,852	25.2	537,498	125.6
Cannonball 2/	1953 3/	7,371	75,965	10.3	251,368	34.1	185,553	25.8	512,886	69.6

1/ Bruises over 2 inches in diameter.

2/ Also known as Black Diamond and Florida Giant.

3/ Preliminary reports, shipments from Southeastern States only.

Source: Reports of Railroad Perishable Inspection Agency.

A frequency distribution of the damage in 229 shipments of the Congo variety of melons in ventilated boxcars included in this sample is shown in figure 1. Figure 2 shows a similar distribution of melon damage for 392 cars of the Cannonball variety taken from the same sample.

Comparison of these two distributions shows, as did table 4, that a greater percentage of shipments of the Congo variety sustained relatively heavy damage than shipments of the Cannonball variety.

The fact that the extremely heavy damage was confined to a relatively small number of shipments suggests that there may have been one or more important damage-producing factors which affected only about 1 out of every 5 cars shipped. The 3 factors most often cited by different trade groups as contributing to relatively high damage rates in comparatively few shipments are (1) lack of proper care in harvesting, handling, and loading of the melons, (2) overmaturity of melons at time of shipment, and (3) excessively rough handling received by some shipments in transit.

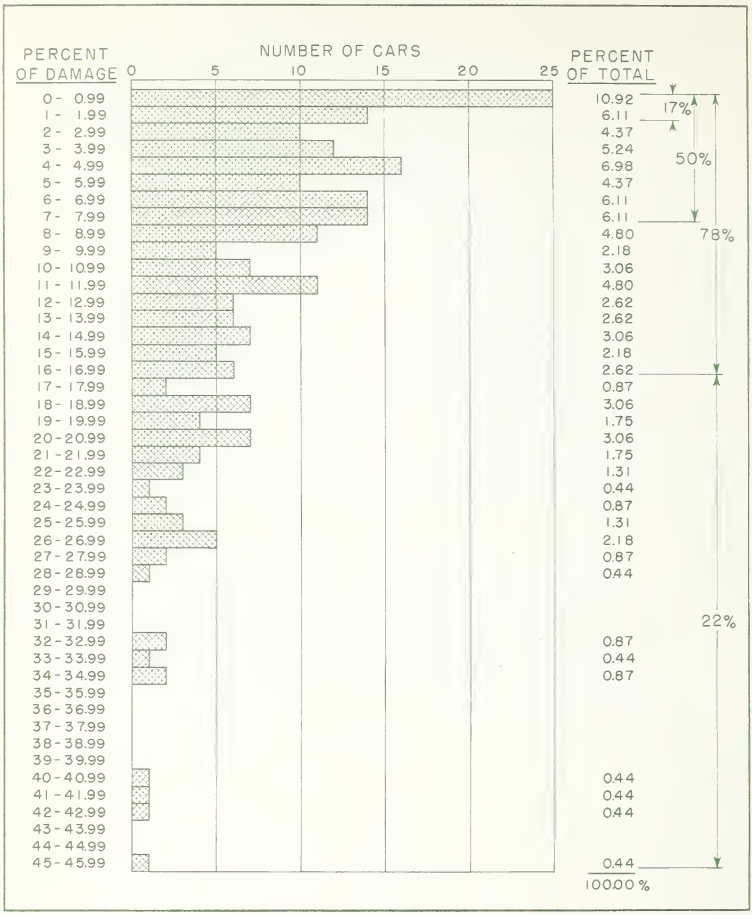


Figure 1.--Frequency distribution of 229 shipments of Congo watermelons in ventilated boxcars by amounts of damage, 41 terminal markets, 1952 season.

Source: 10-percent random sample of all cars of melons inspected and unloaded in markets covered by the Railroad Perishable Inspection Agency. The term *damage* as used here refers to external visible damage, principally bruising and cracking.

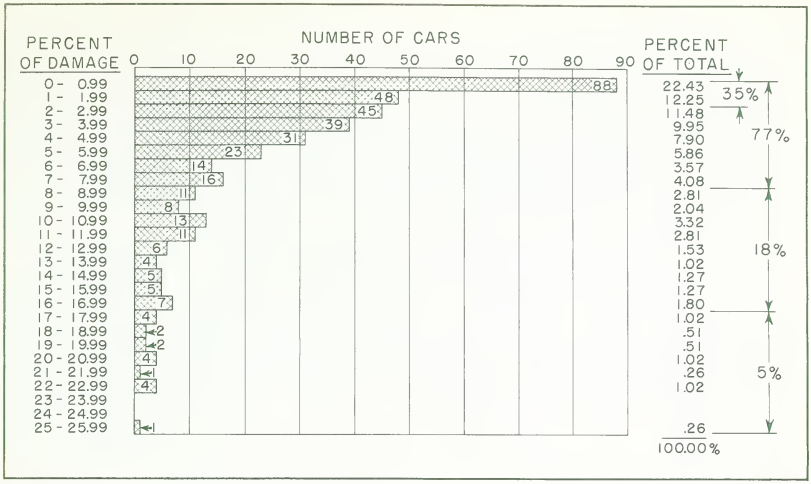


Figure 2.--Frequency distribution of 392 shipments of Cannonball watermelons in ventilated boxcars, by amounts of damage, 41 terminal markets, 1952 season.

Source: 10-percent random sample of all cars of melons inspected and unloaded in markets covered by the Railroad Perishable Inspection Agency. The term *damage* as used here refers to external visible damage, principally bruising and cracking.

METHODS

Types of Cars and Loads Used

Watermelons are one of the very few agricultural perishables loaded and transported to market in bulk. The individual melons are therefore subjected to the same forces and damage hazards incident to transportation as are the individual containers of various types in which most other agricultural perishables are shipped. Numerous tests and observations have shown that in some instances the forces transmitted to the loads of various commodities during rail transportation are of sufficient intensity to completely or partially demolish relatively heavy wood containers. It is therefore not surprising that under these conditions watermelons have always suffered extensive damage in rail shipments.

Several different types of railroad cars are used for the shipment of watermelons from various producing areas in the United States. In the Southeast ventilated boxcars have been the principal type of equipment used for many years, whereas in Texas and Oklahoma stock cars have been used in large numbers. In both areas, refrigerator cars have been used to an increasing extent in recent years to supplement the dwindling supplies of the ventilated boxcars and stock cars. In the producing areas of California and Arizona, refrigerator cars are used exclusively for rail shipment of this commodity.

A previous study showed that the refrigerator car, contrary to the belief in some trade circles, serves as satisfactorily for the transportation of melons as the ventilated boxcar or stock car. 2/

For almost as many years as watermelons have been shipped by rail there has been more uniformity in the methods of loading this commodity for shipment than for almost any other perishable or fragile agricultural product. Probably the principal reason for this lack of variation in loading patterns is that, as the melons are not packaged for shipment, it was generally thought that they lent themselves to one principal loading pattern--the conventional lengthwise-on-sides method.

Conventional Lengthwise Load

In the conventional lengthwise method of loading, the melons are placed on their sides lengthwise of the car with the stem ends toward the doorway (fig. 3). Loading may be begun at both ends of the car and may, if sufficient melons and loaders are available, proceed simultaneously from both ends toward the doorway area. The number of rows 3/ loaded across the car varies with the transverse diameter of the melons.

Figure 4 gives two diagrams showing melon arrangement in the lengthwise load. The first diagram is of a top view of the load with melons in the second layer 4/ superimposed upon those in the first or bottom layer, showing how the load is begun at each end of the car. The second diagram gives a cross section or end view of a stack 5/ of melons. As is shown in these sketches, the load is offset crosswise by alternate layers, as the melons in all upper layers rest in the spaces between the melons in the lower layers, or between one side wall row of melons and the car side wall.

If, at the point in the doorway area where the load has been brought together from both ends of the car, there is not space enough remaining to accommodate another stack of melons loaded lengthwise of the car, 1 or 2 stacks of melons may be loaded crosswise of the car to fill this gap and complete the load. For many years it has been observed that the melons loaded crosswise in the *doorway filler stacks* appeared to suffer relatively little transit damage as compared with melons in other locations in the load, but this fact was generally attributed to the location of the melons in the car rather than the arrangement of the melons in the load.

2/ Gerrity, M. V. and Breakiron, P. L. Loss and Damage in Rail Transportation of Watermelons in Relation to Variety of Melon, Type of Car, and Type of Protective Material. 31 pp. USDA, PMA. June 1950.

3/ A *row* is a line of melons extending lengthwise of the car, 1 melon in width and as high as the load itself.

4/ A *layer* is a course or stratum of melons 1 melon high.

5/ A *stack* is a pile of melons or cross section of the load from one side wall to the other and from the top to the bottom of the load, 1 melon in length.

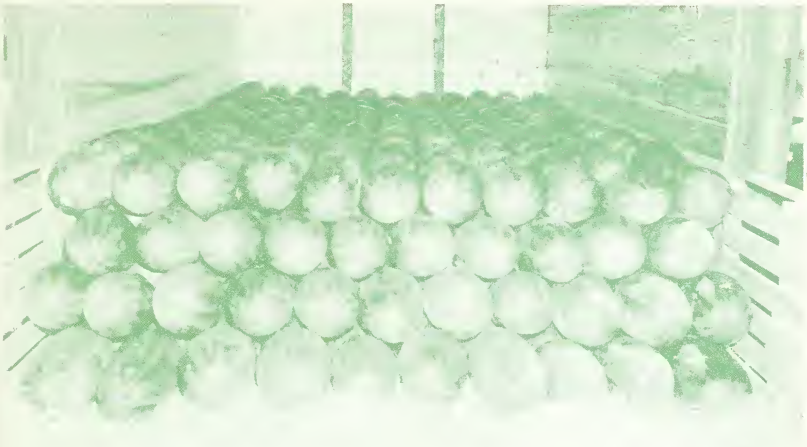


Figure 3.--End, or cross section, view of one of several common lengthwise arrangements of Congo watermelons in doorway area of ventilated boxcar. This photograph was taken during loading of car at shipping point.

The conventional lengthwise method served more or less satisfactorily for many years for the tough, thick-rind, older varieties of melons like the Tom Watson and the Cannonball. In recent years, however, breeding experiments directed principally toward the development of disease-resistant varieties with improved eating qualities have resulted in the production of the Congo and several other long varieties having somewhat thinner, more flexible rinds, particularly at the blossom ends. In the conventional lengthwise load, where the relatively weak blossom ends of these new varieties are in direct contact with the harder stem ends of the other melons in the load, the impacts transmitted lengthwise through the load have resulted in considerable blossom-end bruising (fig. 5).

In the conventional lengthwise loads of the Cannonball, a round variety, there is, because of its blunt stem end and somewhat dished-out blossom end, a considerably greater area of contact between the blossom ends and stem ends of the melons as compared with the limited area of contact in loads of the long varieties. Thus under the same degree of lengthwise impact or pressure throughout the load, the pressure per square inch on the rind at the blossom ends of the melons would be considerably greater for long varieties than for the round varieties.

Some slight changes in the conventional lengthwise loading method were tested by the Department of Agriculture about 7 years ago. The results of this work, which indicated that the modifications studied at that time had little or no effect in

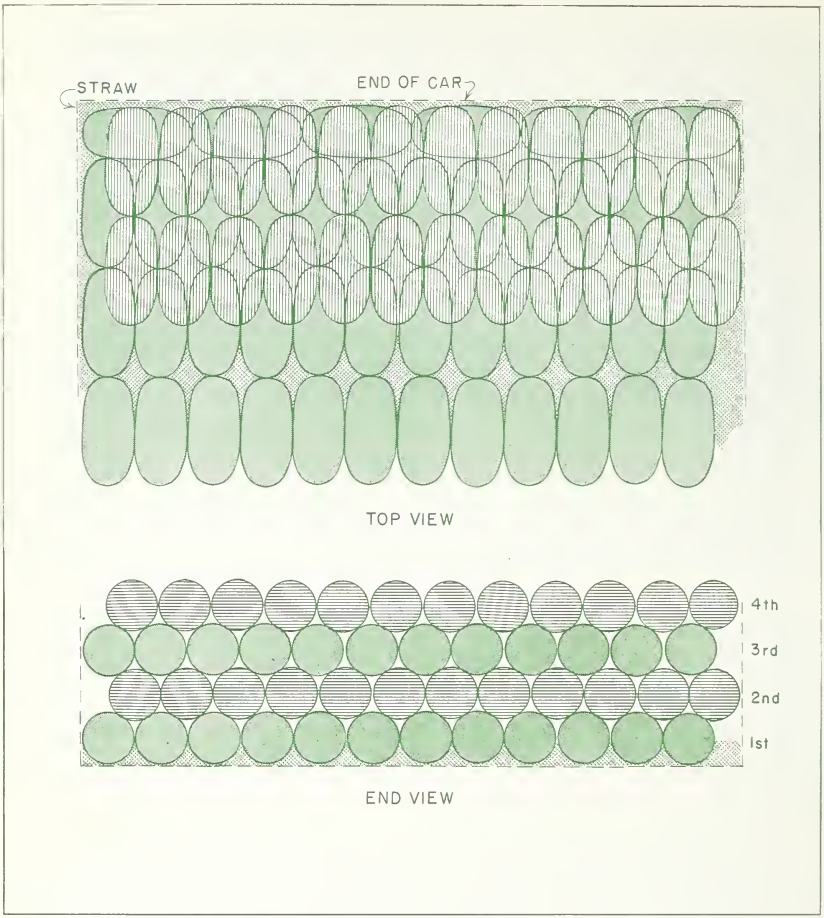


Figure 4.--Top and end views of conventional lengthwise load, showing arrangement of long-type melons. In the top-view sketch the second layer of melons is superimposed on the first, or bottom, layer of melons. In the end view note that melons in three upper layers rest in depressions between adjacent melons directly beneath them.

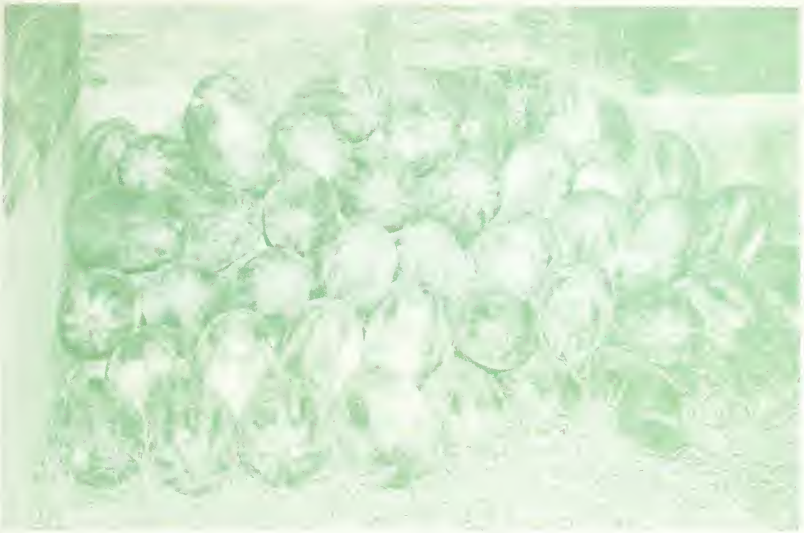


Figure 5.--Cross section view of conventional lengthwise load at destination, showing up-ending and disarrangement of melons at one end of load caused by rough handling of car during transit. This load had 313 damaged melons out of a total of 1,679.

reducing the relatively high rates of damage associated with the use of the conventional lengthwise loads, have been reported elsewhere. 6/

Other Loading Methods

Studies of the shipping and handling of other perishable and fragile agricultural commodities, especially those shipped in various types of containers, have demonstrated that much of the damage associated with the normal hazards of rail shipment can be effectively reduced or eliminated by arranging the packages in the load in such a manner that the lengthwise impacts or thrusts of the load are borne by the heaviest, strongest part of the containers. 7/ At the time this study was begun there was ample reason to believe that similar results could be achieved with watermelons.

6/ Winston, J. R. Report of Watermelon Shipping Tests from South Carolina. H. T. & S. Office Report No. 156. USDA, BPISAE. July 1946.

---------- Report of Watermelon Shipping Test from the Southeast to Northern Markets. H. T. & S. Office Report No. 186. USDA, BPISAE.

7/ Breakiron, Philip L. Reduction of Loss and Damage in Rail Transportation of Fresh Fruits and Vegetables by Improved Loading Methods. USDA, BAE. 80 pp. August 1946.

Winter, J. C. Reduction of Cantaloup Loss and Damage in Rail Transportation Through Use of the Upright Loading Method. USDA, PMA. 16 pp. April 1951.

Accomplishing this objective with watermelons, particularly the long varieties, revolved around the problem of finding a practical and acceptable method of getting the melons out of direct stem-end-to-blossom-end contact lengthwise of the car. A number of possible arrangements of melons in loads could be used to achieve this goal. For purposes of this study during the 1953 season, three types of loading arrangements were chosen--the so-called jumble load, stem-end-to-stem-end loading, and the crosswise load.

Jumble Load

The jumble load, as the name implies, simply consists of placing the melons in the load in a jumbled, random manner. In the jumble load, there is no definite pattern as the melons are placed haphazardly crosswise, lengthwise, on end, or in any other position. The two shipping tests with the jumble load of Congo melons conducted by the railroads in cooperation with several shippers and receivers during the 1952 season, had favorable results. No tests were tried in 1953 because of the lack of interest in this type of load by receivers.

Stem-end-to-stem-end Load

The stem-end-to-stem-end load is the same in outward appearance as the conventional lengthwise load as all the melons are loaded lengthwise of the car. The only difference is that the melons are placed in the car with stem ends against stem ends, instead of stem ends against blossom ends.

Crosswise Load

Figures 6, 7, and 8 show top-view and end-view diagrams of three variations of melon arrangement in the crosswise load. The top-view diagrams, in which the melons in the second layer are superimposed upon those in the first, or bottom layer, illustrate the way each of the loading arrangements is begun at either end of the car. It is to be noted that the melons in the second layer are placed in the space between two adjacent melons in the bottom layer, or between the first stack of melons and the end wall of the car. In all three arrangements the loads should be constructed in such a way that the top layer, and each alternate layer beneath it, are in tight contact with the padding on both end walls of the car.

In the loading arrangement shown in figure 6 all melons in the load are placed crosswise of the car and are offset crosswise by layers. If the melons in the load are fairly uniform in size, all stacks will usually contain the same number of melons. The excess space at one side of each stack not occupied by a melon should be packed with straw or other bedding material.

Loading arrangements shown in figures 7 and 8 are modifications of the arrangement shown in figure 6, the only difference being that figure 7 and 8 show 4 lengthwise rows of melons, 2 along each side wall. In figure 7 there are 2 lengthwise rows in each of the first, and third layers, 1 along each car side wall, whereas in figure 8 there is 1 lengthwise row in each of the 4 layers on alternate sides of the load.

In most of the experimental crosswise loads shipped during the 1953 season, the loading arrangement shown in figure 6 was used. The 2 principal disadvantages of this

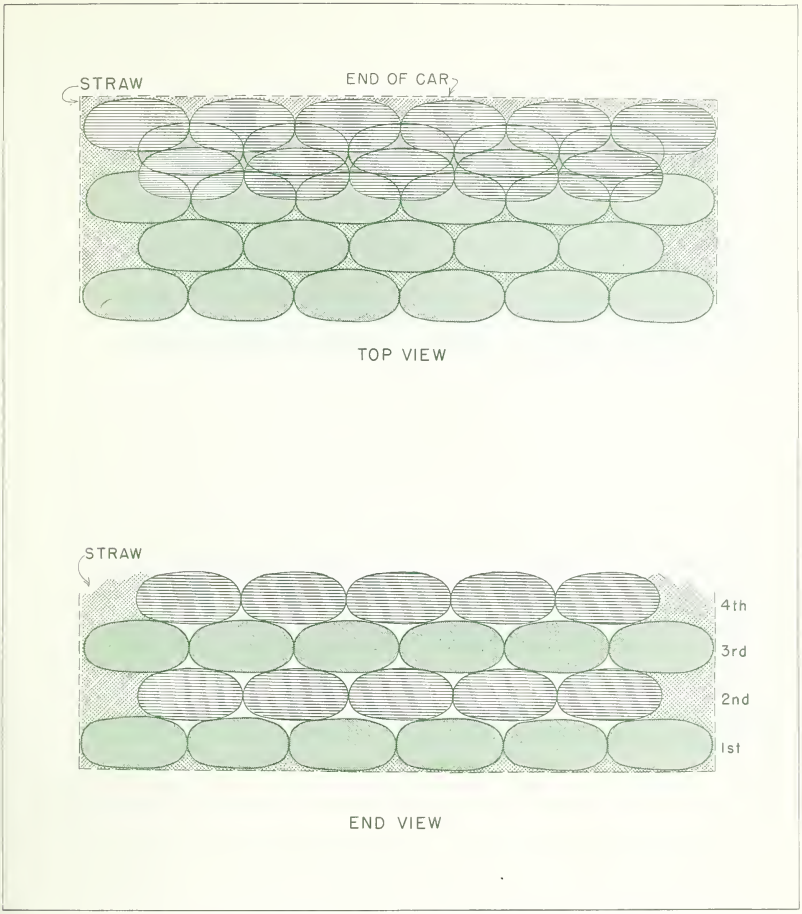


Figure 6.--Top and end views of crosswise load, showing arrangement of long-type melons. In the top view 2 stacks of melons in the second layer are superimposed upon first, or bottom, layer of melons. Note in top view that melons are offset from those in bottom layer as they rest in depressions between 2 melons in bottom layer, or between the first stack of bottom layer melons and the end wall of the car.

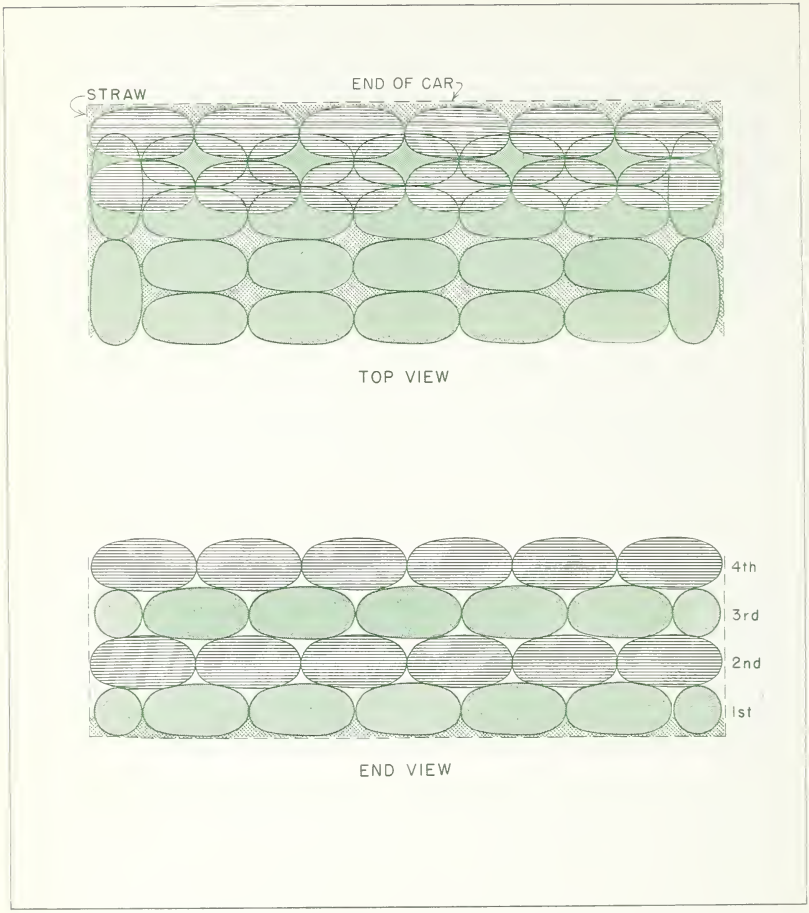
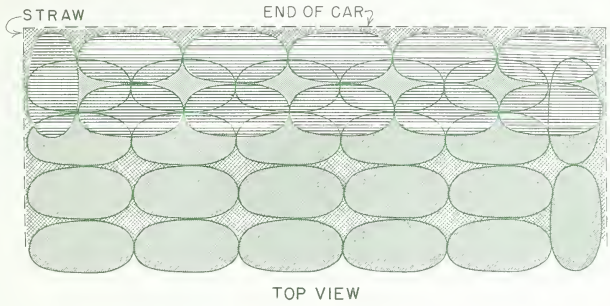


Figure 7.--Top and end views of crosswise load of long-type melons with lengthwise rows of melons on each side of the first and third layers. Although this arrangement produces a more compact load, it offsets to some extent the principal advantage of the crosswise load as it involves the added risk of blossom-end bruising of the melons in the lengthwise rows.



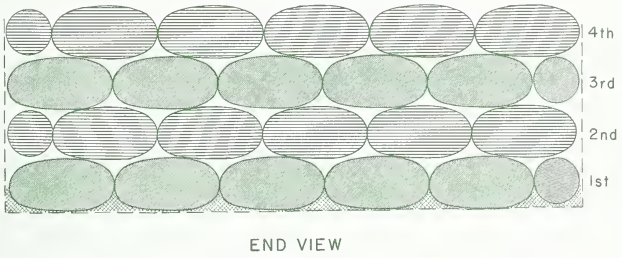


Figure 8.--Top and end views of crosswise load of long-type melons with one lengthwise row along alternate sides of each layer. In top view, second layer melons are superimposed on those in bottom, or first, layer. Straw or other bedding material is sometimes placed in spaces at sides of first and second layers instead of lengthwise rows of melons.

arrangement are that, because of the unfilled voids at alternate sides of each layer, the load is from 5 to 10 percent lighter than a lengthwise load of the same size of melons, and that it tends to become somewhat disarranged during transit. Through the use of the arrangements shown in figures 7 and 8, part of the disadvantage of the crosswise load because of weight loss may be overcome. This would be desirable for small melons which are most likely to make underweight loads. These modifications in the load offset to some extent the principal advantage of the crosswise load by increasing the risk of blossom-end bruising to melons in the lengthwise rows. Further tests of these crosswise load variations, however, are needed to evaluate their performance under different shipping conditions.

The construction of crosswise loads proceeds in the manner just described and illustrated in figures 6, 7, and 8, from both ends of the car toward the center or doorway area, the bottom layer of melons always being loaded ahead of the melons in the top layer of the preceding stack. Fiberboard wedges, or a small amount of straw or similar material, may be placed under the melons on the floor in starting a stack to keep the melons from rolling out of place (figs. 9 and 10).

Figure 9.--Cross section of crosswise load of Congo melons, showing how load is begun at either end of car and the use of fiberboard wedges under bottom layer melons to hold them in place as load is built toward doorway area. Bedding material on car floor is straw and end wall is padded with excelsior pads.

Shipment and Inspection of Test Cars

To determine how many experimental test shipments would be required to test adequately a given loading method or device, the previously mentioned data on the distribution of damage found in a 10-percent random sample of cars unloaded in 41 terminal markets during the 1952 season were analyzed. The results indicated that 100 tests would have to be made

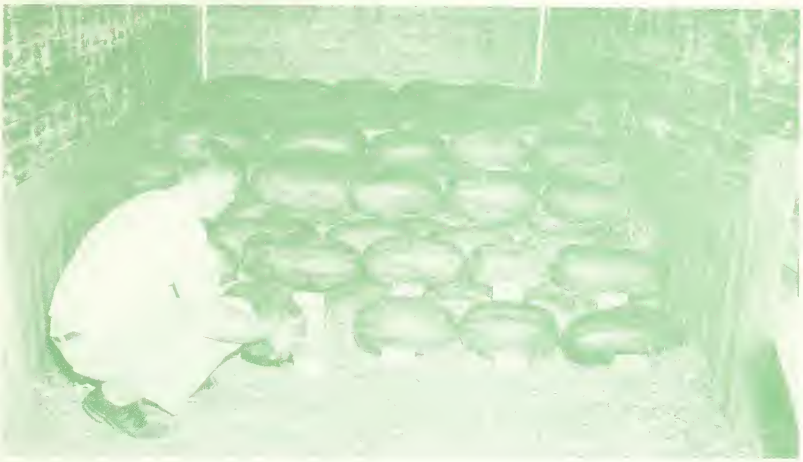


Figure 10.--Cross section of crosswise load of Congo melons at quarterlength position (half way between doorway and one end of car) showing construction of load and placement of bottom layer melons on fiberboard wedges.

of any one loading method or device to provide a statistically significant 8/ basis for conclusion regarding its value.

Because of the relatively short duration of the watermelon shipping season by rail, it was possible to run only 50 shipping tests of the crosswise load, the principal type of experimental loading method under study, and 8 of the blossom-end-to-blossom-end method. But, differences between rates of damage in the test cars loaded crosswise and the check cars loaded lengthwise (conventional method) were found to be large enough to justify a preliminary report.

The actual loading of each test shipment and of most companion or check cars was performed or supervised by representatives of the Department of Agriculture. Observations were made of the suitability of each car used for loading, the amount and type of bedding, padding, and other protective material used in preparing each car for loading and the degree of care used in handling and loading the melons. All melons used in most test and companion loads were inspected by the Federal-State Inspection Service. Approximately half of the test and companion loads were equipped with impact recording devices in

---

8/ Allowing for 10-percent sampling error; that is, the probability that this number of test shipments would give results which were not statistically significant is estimated to be about 1 in 20.

order to determine the comparability of the test and check loads from the standpoint of the type of handling received in transit. Of the total test and check cars, 45 originated in Florida, 16 in Georgia, and 49 in South Carolina.

Upon arrival of the cars at terminal markets, the loads were inspected and the amount, type, location, and apparent cause of damage and decay were noted as the melons were removed from each load. Of the total of 110 cars studied, 84 were inspected by Department of Agriculture personnel and most of these were inspected jointly with the Railroad Perishable Inspection Agency and the Western Weighing and Inspection Bureau; 26 shipments were inspected by only the railroad inspection agencies. Observations also were made of the condition and adequacy of bedding and padding material and various other protective materials in the cars.

RESULTS

Comparative Melon Damage by Type of Load

Damage found in all test and check shipments was separated into various types, including bruising, cracking, and scarring. For purposes of evaluating the performance of various types of loads from the standpoint of the relative amounts of damage found in each, more emphasis is placed on cracking and external bruising than on scarring or other minor damage to the surface of the melons. Cracking and bruising adversely affect the marketability of the melons to a much greater extent than do the other types of minor surface injury.

As stated previously, each test shipment was accompanied by a companion or check shipment when it left the shipping point. Because many cars were sold and diverted in transit, however, most of the paired shipments did not go to the same destination, although many of them moved together for at least part of the distance. This situation in the distribution of the test and check shipments determines the types of comparisons that can be made with the data covering the amounts of damage and decay found in all test and check shipments.

A comparison of the type and amount of damage found in 50 crosswise test loads and 52 lengthwise loads of the Congo variety, is shown in table 5. Of the total of 50 pairs of cars, on which data on the loss and damage at destination were obtained, only 12 pairs went to the same destinations. These data reveal that in these 12 pairs, the crosswise loads had 2.75 percent external bruising as compared with 11.87 percent for the conventional lengthwise loads. In addition, the number of cracked melons in the experimental crosswise loads was only one-fourth that found in the conventional loads, being 0.21 percent and 0.87 percent for the 12 crosswise and 12 lengthwise loads, respectively.

Comparing all 50 crosswise test loads, including those separated from their companion shipments in transit, with the 52 lengthwise loads, the record of the crosswise load from the standpoint of the amount of external bruising and cracking is again superior. The crosswise loads sustained 4.62 percent bruising, as compared with 15.63 percent for 52 lengthwise loads, a reduction of 70 percent in favor of the crosswise load. The 52 lengthwise loads had more than three times as much damage from cracked melons as did the 50 crosswise loads.

Table 5.--Amount and type of damage found in test and check shipments of Congo watermelons, by type of load, 1953 season

Type of load and basis of comparison	Test cars	Average number melons per car	Percentage of melons cracked	Percentage of melons bruised	Percentage of melons scarred	Total percentage of damaged melons
	Number	Number	Percent	Percent	Percent	Percent
12 paired cars						
Lengthwise	12	1,076	0.87	11.87	0.29	13.04
Crosswise	12	973	.21	2.75	.09	3.04
Reduction			75.9	76.8	68.9	76.6
All cars						
Lengthwise	52	1,047	1.02	15.63	.17	16.82
Crosswise	50	985	.32	4.62	.09	5.03
Reduction			68.7	70.4	47.1	70.1
Range (all cars)						
Lengthwise	52		0 - 5.8	.81 - 52.2	0 - 1.7	
Crosswise	50		0 - 2.5	0 - 30.9	0 - 1.0	

In the 50 crosswise loads, bruising ranged from 0 to 30.9 percent, whereas in 52 lengthwise loads it ranged from 0.81 to 52.1 percent. The range in cracking was from 0 to 5.8 percent for the 52 lengthwise loads and from 0 to 2.5 percent for the crosswise loads. Scarring of the surface of the melons ranged from 0 to 1.7 percent for the lengthwise loads and from 0 to 1.0 percent in the crosswise loads.

Damage resulting from surface scars, as indicated by these data, was negligible. The difference in scarring, however, was also in favor of the crosswise loading method. Probably the principal reason for this is that in the crosswise loads there is normally far less surface area of the melons in direct contact with the side walls of the car than in the lengthwise loads. Most of the severe surface scarring in the lengthwise loads was found in the rows of melons in direct contact with the side walls of the car and the door boards or door gates.

Table 6 gives the comparative damage in eight lengthwise split loads of Congo melons for which complete information on the number of damaged melons in each loading arrangement is available. In these loads one-half the rows of melons on one side of the car were loaded stem-end-to-stem-end and the melons in the rows on the other side of the car were loaded in the conventional stem-end-to-blossom-end arrangement. These data show that although the stem-end-to-stem-end loading arrangement had somewhat less total damage than the conventional stem-end-to-blossom-end arrangement, the performance of this type of load was not as good as the crosswise loading method. Under the stem-end-to-stem-end arrangement, the melons showed 5.8 percent bruising as compared with 7.4 percent for the conventional stem-end-to-blossom-end method. The amounts of cracking of the rinds and severe surface scarring were negligible for both loading arrangements.

Bruising in the lengthwise loads, including both the conventional and the stem-end-to-stem-end method, occurred predominately on the blossom ends of the melons. Data in table 7, covering 66 shipments for which detailed information on the type and location of damage was obtained, disclose that from 90 to 95 percent of all damage in both types of lengthwise loads consisted of blossom-end bruising. In contrast, only 40.1 percent of the total damage in the crosswise loads was found to be blossom-end bruising. In most instances severe blossom-end bruising appeared as cup-like depressions,

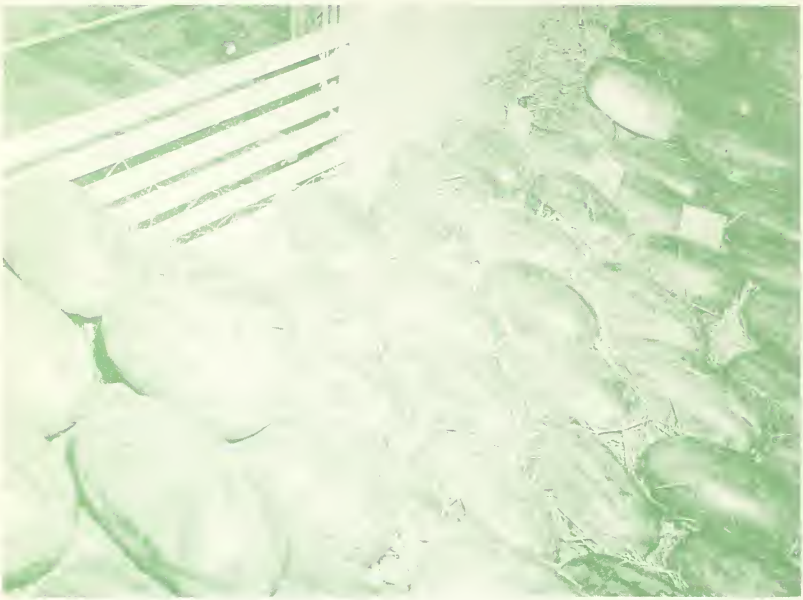


Figure 11.--View of crosswise load of Congo melons at doorway area in ventilated boxcar, showing how two sections of load from ends of car are brought together at this point.

varying from as little as 1/8 to about 3/4 of an inch in depth and from 1½ to 4 inches in diameter. Light to moderate bruising at this point frequently produced no concave depressions in the rind and could only be detected by feeling the blossom end of each melon to determine whether the rind was broken or softened by bruising injury. Although this type of blossom-end bruising was found throughout the entire length of the loads, it was concentrated mostly in the melons at the ends of the car, particularly the end toward which the heaviest lengthwise impacts and shifting of the load were directed.

A very substantial part of the bruising found in the crosswise loads occurred as relatively large bruised areas on the sides of the melons. The data on bruising in table 7 show that 48.8 percent of the melons bruised in the crosswise loads were affected principally with side bruises. Although there was less bruising in the crosswise than in the lengthwise loads, the individual bruised areas were generally larger than those on the blossom ends of the melons in the lengthwise loads. In the crosswise loads there is a greater area of contact between the melons in different stacks, as compared with the lengthwise loads, over which the pressure of the lengthwise

Table 6.--Amount and type of damage found in 8 lengthwise split loads of Congo watermelons, by type of loading arrangement, 1953 season

Arrangement of melons in load	Melons cracked		Melons bruised		Melons scarred		Total melons damaged	
	Quantity of melons	Percentage of total melons	Quantity of melons	Percentage of total melons	Quantity of melons	Percentage of total melons	Quantity of melons	Percentage of total melons
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Stem-end-to-stem-end 1/	27	0.3	514	5.8	2	0.02	543	6.1
Stem-end-to-blossom-end	39	.4	661	7.4	0	0	700	7.9

1/ Under this arrangement the melons would also be blossom-end-to-blossom-end.

thrusts of the load is spread. Although this materially reduces the pressure per square inch of rind area at the point of contact, thereby helping to reduce the total amount of bruising, it also means that when the lengthwise load thrusts are of sufficient intensity to produce bruising, the injury will likely cover a larger area of the rind.

The data in table 7 also show that all types of melon damage occurred predominately to melons in the end sections of the car whereas relatively little damage was found in melons in the doorway part of the loads. From 89 to 98 percent of all bruised melons were found in the end sections of the car. Although the doorway area, which comprises that part of the car between edges of the door openings and extending across the width of the car, had 16.7 percent of the available loading space in the ventilated boxcars which were used in most of the tests, this part of the load contained only 7.7 percent of the damaged melons in the conventional lengthwise loads and 10.1 percent of the damaged melons in the crosswise loads.

Table 7.--Location of damaged melons in cars and location of bruises on melons in different types of loads, rail shipments of Congo watermelons, 1953 season

Type of load	Test cars	Location of damaged melons in car (Percentage of total damage)			Location of bruises on melons		
		A end of car 1/	B end of car 2/	Doorway area 3/	Blossom end	Stem end	Sides
	Number	Percent	Percent	Percent	Percent	Percent	Percent
Crosswise loads	37	42.5	47.3	10.1	40.1	11.1	48.8
Conventional lengthwise loads	24	38.6	53.7	7.7	95.3	.5	4.2
Split lengthwise loads 4/	5						
Stem-end-to-stem-end		53.2	44.4	2.4	92.5	3.2	4.4
Stem-end-to-blossom-end		45.0	53.4	1.5	90.9	3.1	6.1

1/ Opposite end from brake end.

2/ Brake end.

3/ Area extending lengthwise of car equal to width of doorway opening and across the car from one door to the other.

4/ One-half of melons on one side of car loaded stem-end-to-stem-end, melons on other side of car stem-end-to-blossom-end.

Shipments from some areas were bedded with insufficient quantities of straw on the car floors, or with straw having relatively thick, heavy stems and little cushioning property. Preparation of the side walls and installations of the door boards and doorway gates appeared to be adequate and very few instances were observed where melon damage resulted from protruding nails, bolts, or door boards along the side walls of the cars. Friction bruising, or severe rubbing of the melons, at this point was also negligible.

The most serious deficiency observed in the preparation and padding of the cars was the lack of adequate protection on the end walls. In most cars the excelsior pads used for this purpose did not overlap enough to provide adequate cushioning and at destination it was observed that the filling of the pads had worked out of the open ends and greatly reduced the cushioning properties when they were most needed.

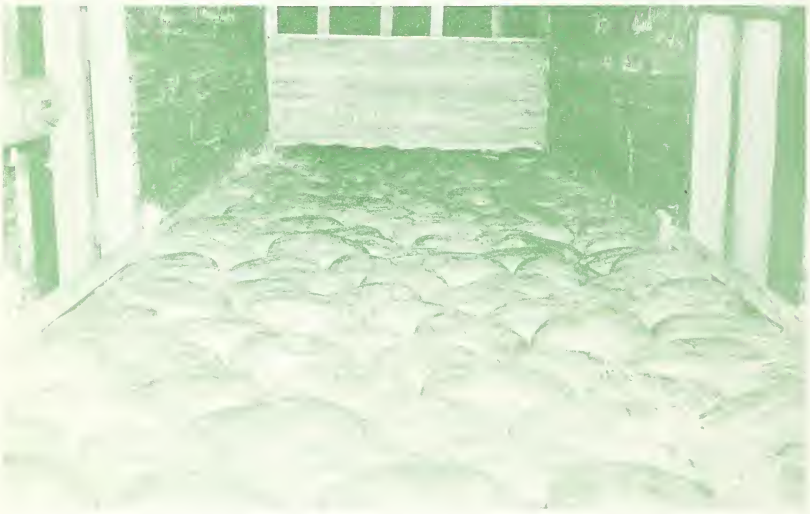


Figure 12.--View of completed crosswise load of watermelons in a refrigerator car.

Decay by Type of Load

Table 8 presents a breakdown of the total amount of decay found in 20 paired lengthwise and crosswise loads and in all 83 test and check shipments inspected by personnel of the Department of Agriculture. The 10 paired crosswise cars averaged 1.75 percent decay as compared with 1.65 percent for the lengthwise loads. However, all 38 crosswise loads, for which a breakdown of this information is available, averaged 1.90 percent decay whereas 45 lengthwise loads had an average of 2.80 percent.

Table 8.--Amount and type of decay found in test and check shipments of Congo watermelons, by type of load, 1953 season

Type of load and basis of comparison	Total melons in cars inspected	Total decay		Type of decay (percentage of total decayed melons)							
		Melons	Percentage of total melons in cars inspected	Anthracnose	Stem-end rot	Bacterial soft rot	Blossom-end rot	Rhizopus rot	Internal souring	Soil rot	Other or unknown
	Number	Number	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
10 pairs of cars:											
Lengthwise (10 cars)	10,869	179	1.65	0.56	69.27	11.73	14.52	0	0	1.68	2.23
Crosswise (10 cars)	9,692	170	1.75	-	78.23	10.00	8.24	.58	2.35	0	.59
All cars:											
Lengthwise (45 cars)	47,800	1,341	2.80	.67	58.24	11.26	19.24	.15	1.64	1.19	7.60
Crosswise (38 cars)	37,489	711	1.90	1.41	75.53	9.42	8.44	.42	.98	1.55	2.25

Stem-end rot, which was found to be the most prevalent type of decay, accounted for 75.5 percent of the decay in 38 crosswise loads and 58.2 percent in 45 lengthwise loads. This finding regarding the prevalence of stem-end rot in relation to other types of decay also confirms the results of previous investigations. 9/

Because of the various factors affecting infection of the melons and spread of decay, relatively little significance can be attached to the data in table 8 relating to the prevalence of all types of decay.

A relatively large percentage of the total decay was found to consist of blossom-end rot. The amount of this decay was significantly larger in the lengthwise loads than in the crosswise loads, accounting for 8.44 percent of total decay in all crosswise loads as compared with 19.24 percent of the total decay found in all lengthwise loads. Considering the high incidence of blossom-end bruising in the conventional lengthwise loads, the results suggest that part of the blossom-end decay in the lengthwise loads may have developed subsequent to severe bruising injury to this part of the rind.

Bacterial soft rot had a fairly high incidence, affecting about 1 out of every 10 decayed melons. Other types of decay, including anthracnose, rhizopus rot, internal souring or fermentation, and soil rot, were relatively unimportant. None of these decays accounted for more than 2.5 percent of the total melons lost through decay.

A comparative breakdown of the total amount of decay found in eight split lengthwise loads of Congo watermelons, in which half the melons on one side of the car were loaded stem-end-to-stem-end and those in the remaining half of the load stem-end-to-blossom-end, is given in table 9.

In both types of loading arrangements stem-end rot was also found to be the most prevalent type of decay. As was the case with the data in table 8, little significance can be attached to the data for other types of decay because of the relatively small number of melons decayed.

9/ See footnote 2, page 8.

Table 9.--Amount and type of decay found in 8 *split* lengthwise loads of Congo watermelons, by type of loading arrangement, 1953 season

Arrangement of melons in load	Total melons in loading arrangement	Total decay		Type of decay (percentage of total decayed melons)							
		Melons	Percentage of total melons	Anthracnose	Stem-end rot	Bacterial soft rot	Blossom-end rot	Rhizopus rot	Internal souring	Soil rot	Other or unknown
	Number	Number	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Stem-end-to-stem-end 1/	4,909	72	1.47	1.39	45.83	18.06	22.22	0	0	1.39	11.11
Stem-end-to-blossom-end	4,909	104	2.12	0	45.19	12.50	26.92	0	4.81	3.85	6.73

1/ Under this arrangement the melons would also be blossom-end-to-blossom-end.

Lengthwise Impacts in Relation to Melon Damage

The objective of placing impact registers in as many test and check shipments of melons as possible during the program of shipping experiments was threefold. Some relative measurements of the lengthwise impacts transmitted to the loads during transit were required to determine: (1) The relationship between the frequency and severity of lengthwise impacts and the degree of damage in different types of loads; (2) the comparability of test and check or companion shipments from the standpoint of the relative severity of the handling in transit; and (3) the location at which any overspeed impacts may have occurred in order that such information could be brought to the attention of the proper damage prevention officers of the particular railroads concerned, with a view to reducing rough handling of all shipments.

In order to implement point (3) above, the train, or running, record of each car was requested from the railroads participating in the haul, at the time that the impact records on each car were furnished to the damage prevention officer of each participating carrier. The information thus obtained from the carriers was analyzed to pinpoint the locations at which most of the overspeed impacts occurred. As the time and speed at which each impact occurred were shown on the records furnished to the railroads, each of the carriers involved was able to determine which, if any, of the impacts occurred on its line.

A comparison of the number and intensity of the impacts received in transit and the total damage to the crosswise, conventional lengthwise, and *split* lengthwise loads which were equipped with impact recorders is given in table 10. This comparison reveals that, although there was less than one-third as much damage in the crosswise loads as in the lengthwise loads, as indicated previously, the number and magnitude of impacts were greater for the crosswise test cars.

In order to measure the relationship of in-transit impacts to the severity of damage to the melons in test cars, an average impact force index was developed for each car containing an impact register. The impact force index is based on findings of railroad research technicians that, when two railroad cars come together, the force of the impact

Figure 13.--Internal view of Congo melon at destination. Note thinness of light-colored rind at blossom end (left) as compared with rind on sides of melon.

received by the load is in the approximate ratio of the square of the striking speed. Striking impacts of 4 miles per hour or less are considered normal handling. The index was developed for each car by squaring the speed of each recorded impact over 4 miles per hour, and adding the resulting units of destructive force.

Average impact force indices so developed for the 3 types of loads with more than average damage and less than average damage per car are given in table 11. In the conventional lengthwise and *split* lengthwise loads more than average damage was associated with relatively high impact force indices and less than average damage with comparatively low impact indices. In 31 crosswise loads, however, the 8 cars with more than average damage had an impact force index approximately the same as for the 23 cars that had less than average damage. The fact that damage in the crosswise load did not vary directly with number and intensity of the impacts received by the loads during transit suggests that there were other factors that influenced the amount of damage. Further tests and experiments, however, are needed to determine the relative importance of the force of impact and other factors on the amount of damage to the melons in different types of loads.

Table 10.--Comparison of number and intensity of lengthwise impacts in transit received by 59 cars of Congo watermelons and percentage of damaged melons, by type of load, 1953 season

Type of load	Cars with impact registers	Impacts occurring at speeds of more than 4 miles per hour 1/	Average impacts occurring at speeds of more than 4 miles per hour	Average impact force index per car 2/	Percentage of cracked and bruised melons
	Number	Number	Number	Number	Percent
Crosswise loads	31	222	7.2	251.5	4.99
Conventional lengthwise loads	23	157	6.8	241.1	16.04
Split lengthwise loads 3/	5	44	8.8	310.2	12.25

1/ Impacts occurring at speeds of more than 4 miles per hour are considered by railroads to constitute rough handling.

2/ Obtained by squaring the speed of impact, as destructive force transmitted to load increases at approximately the same ratio as the square of the speed of impact.

3/ One-half melons on 1 side of car loaded stem-end-to-stem-end; melons on other side of car, stem-end-to-blossom-end.

The percentages of the total lengthwise impacts at various speeds in excess of 4 miles per hour and the percentages that were received in yards or terminals by the 3 types of loads in which impact registers were placed are shown in table 12. Impact, or coupling speeds, in excess of 4 miles per hour, are generally considered rough handling by the railroads as the destructive force transmitted to the car body and thence to the load are considerably greater at speeds above this rate than from impacts at speeds below it. Consequently, although impacts at 5 miles per hour are sometimes considered by some railroads to be at or near the borderline of rough handling, impact speeds at 6 miles per hour and above may definitely be considered rough handling.

Table 11.--Average impact force index for rail shipments of Congo watermelons with more than and less than average damage, by type of load, 1953 season

Type of load	Total cars	Average number of melons cracked and bruised per car	Shipments with more than average damage			Shipments with less than average damage		
			Cars	Average number of melons damaged per car	Average impact force index 1/	Cars	Average number of melons damaged per car	Average impact force index 1/
	Number	Number	Number	Number		Number	Number	
Crosswise load	31	49.7	8	129.5	249.0	23	18.3	252.3
Conventional lengthwise loads	23	164.1	9	299.5	326.2	14	77.1	186.4
Split lengthwise loads 2/	5	137.0	2	232.5	333.5	3	74.0	286.3

1/ As the destructive force transmitted to the load increases at approximately the same ratio as the square of the speed of impact, the index for each car represents the sum of the squares of the striking speeds for each impact over 4 miles per hour.

2/ One-half of melons on 1 side of car loaded stem-end-to-stem-end; melons on other side stem-end-to-blossom-end.

In the 31 crosswise loads, 41.5 percent of impacts above 4 miles per hour were higher than the borderline speed of 5 miles per hour as compared with 41.4 percent for the conventional lengthwise loads and 52.3 percent for the *split* lengthwise loads. Comparison of the time records on the impact register tapes with the train records for each car reveals that from 75.2 to 88.6 percent of all impacts at 5 miles per hour and above occurred in yards or terminals. The results of this analysis emphasize the need for more careful handling of rail shipments at these points.

Table 12.--Percentage of impacts above 4 miles per hour at different speeds and locations at which received, 59 cars of Congo watermelons, by type of load, 1953 season

Type of load	Number of cars with impact registers	Percentage of impact above 4 miles per hour							Percentage of total impacts occurring in yards or terminals
		5 miles per hr.	6 miles per hr.	7 miles per hr.	8 miles per hr.	9 miles per hr.	10 miles per hr.	11 miles per hr.	
	Number	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Crosswise loads	31	58.56	20.76	9.01	7.21	2.70	1.80	0	75.22
Conventional lengthwise loads	23	58.60	22.29	10.19	1.91	4.46	1.27	1.27	77.71
Split lengthwise loads 1/	5	47.73	31.82	13.64	4.55	-	2.27	0	88.60

1/ One-half of melons on 1 side of car loaded stem-end-to-stem-end; melons on other side of car stem-end-to-blossom-end.

☆U. S. GOVERNMENT PRINTING OFFICE : 1954 O - 299610